Improving The Visualization of Geologic Data Using Google's KML

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(KML elements).-Google, 2008a 25

DEDICATION

This work is dedicated to my son Emile Arrey and my late father Papa Peter Arrey who died late last year.

ABSTRACT

The fast growing nature of technology and computing has facilitated computation in many areas of science and engineering. The geosciences more than ever is also benefitting from these innovations to make sense of mapping. With the aid of geobrowsers like Google Maps and Earth, geoscientists can now tell their stories in ways even a nonscientist can understand. This paper therefore examines how Keyhole Markup Language (KML) can be used to improve the visualization of geologic data, like the earthquake data of Ohio. This paper will explore different ways of using KML to represent this information using three dimensional shapes. This research also shows that KML and geobrowsers offer great potential for visualizing geological data. However, a number of challenges must be resolved to realize this potential.

ii. ACKNOWLEDGEMENTS

First and foremost I want to thank Dr. Ralph von Frese for advising me on this project. Dr. von Frese who proposed the project to me in summer of 2009 has helped in many ways to make me believe in myself. I have learned during this project to face challenges and also how to overcome them. Elsewhere, in his geomathematical analysis class, he gave me the tools to succeed in graduate school and even in a professional setting. In my humble opinion he is an innovator in the School of Earth Sciences.

I could not have completed this work without the help of my friend Ebenezer Odoi, who spent lots of hours tutoring me on technical computing. He also gave me the encouragement that I needed to complete the work. Thanks to Dr. Mike Hansen of OhioSeis for pointing me to the earthquake data of Ohio. Finally, I will also like to thank Dr. Ann Carey for her patience and support throughout my stay at the School of Earth Sciences.

a. ACRONYMS

- KML – Keyhole Markup Language
- XML - eXtensible Markup Language
- API- Application Programming Interfaces
- HTML - HyperText Markup Language
- PHP- Hypertext Preprocessor
- VBA - Visual Basic for Applications

b. LIST OF FIGURES

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1.0 INTRODUCTION

The purpose of this thesis is to examine how Keyhole Markup Language (KML) can be used for thematic mapping to improve visualization of inhomogeneous data. KML, originally created in 2001 by a company called Keyhole as a data format for its Earth browser named Earth Viewer (Wernecke 2008), is an XML data format which is used to display information in a geographic context. Just as web browsers read and display HTML files, Earth browsers such as Google Earth read and display KML files. The use of KML enables the presentation of a geologic data set and imagery over the global palette provided by many popular Earth browsers such as Google Earth. KML is a 3D system: length, width and depth are the typical three dimensions in 3D but in this context it is longitude, latitude and altitude that form the three dimensions.

As earlier mentioned, Keyhole Markup Language (KML) is not primarily targeted towards thematic mapping, but it is possible to use KML elements in ways that were probably not intended. These experiments show that KML and associated supported geobrowsers offer great potential for thematic mapping, but that there are significant issues that need to be resolved.

Within the last decade powerful tools for geographic visualization have become common. Google Earth, Google Maps and Microsoft Virtual Earth amongst others are freely available to the public. Geobrowsers are tools that allow access to Georeferenced data over the internet with capabilities that span 2 and 3 dimensions. Prior to the geobrowsers boom, map users used general-referenced maps that focused on features like roads, shorelines, lakes, etc. Desktop Geographic Information Systems (GIS) helped fuel the interest to create and view thematic maps easily. Thematic maps normally show spatial patterns of a social or physical phenomenon, such as population density, life expectancy or climate change. Thematic mapping is a common capability in GIS, but, surprisingly the geobrowsers have not focused much on this powerful geographic representation.

Many users of geobrowsers are normally drawn to it because of the initial fascination of zooming in from high-altitude to street-level. Other users are also drawn in with the visualization of the real world that geobrowsers provide via satellite images. User generated content has fueled the usefulness of this powerful tool (Butler, 2006). Using Application Programming Interfaces (API), programmers can write scripts that generate interactive mapping applications based on content from singular or diverse sources over the internet. 3-D virtual globes such as Google Earth use the Perspective Orthographic Projection to represent the earth. This projection is inherent in the human visual system (Goodchild, 2008).

Achieving this goal by creating a KML file and importing it on Google Earth is not without challenges. This thesis assesses these challenges, discusses them and concludes by presenting earthquake data for geobrowsing.

1.1 BACKGROUND

In geology, representation of features is very crucial to understanding underlining physical conditions. Maps were the primary mode of data visualization until the emergence of digital files. Now dynamic maps tell compelling thematic stories and show data through timelines with multiple layers supporting clear arguments of the nature of our environment. Representing geological data digitally has not been emphasized a lot, especially in terms of their inhomogenieties. There is considerable need to display basic geological data clearly and concisely and with as little add-ons as possible so that data can be easily 'read' by even novice map readers.

On the web now, almost all mapping standards are falling in line with the precedence of KML and its features. There must be an additional attempt to display geological data in a unique way to harness the full potential of data understanding.

2.0 METHODOLOGY

2.1 ANATOMY OF KML

The goal of this paper is to provide insights on the application of KML in visualizing the Earth Sciences and to help jump start future work that will be beneficial to this area of study. That said, an attempt will be made in subsequent lines to explain the basic structure of a KML file.

Every KML file begins with two lines:

<? xml version= "1.0" encoding = "UTF-8" ?>

<kml xmlns= http://www.opengis.net/kml/2.2>

As shown above, every KML file must end with a closing tag </kml>. A KML file also contains a <placemark> element that has three children namely: <name>, <description>, and <point>.

The name is the label for the placemark.

The description comprises of the text which provides additional information about the placemark. The <description> appears in the information balloon. This balloon pops when the user clicks the placemark name in the places panel or the placemark icon in the 3D viewer of Google Earth.

The point contains the <coordinates> element. The <coordinates> element contains values for the longitude, latitude, and altitude of the <placemark>.

Because KML is a XML data format, it consistently follows certain patterns. An element begins with its name in angled brackets (<placemark>). An element ends with an angled bracket and a slash preceding the element name (</placemark>). The element's value is contained within these delimiters. **Figure 1** illustrates some of the main features of KML whereas **Figure 2** gives some syntax for the KML code.

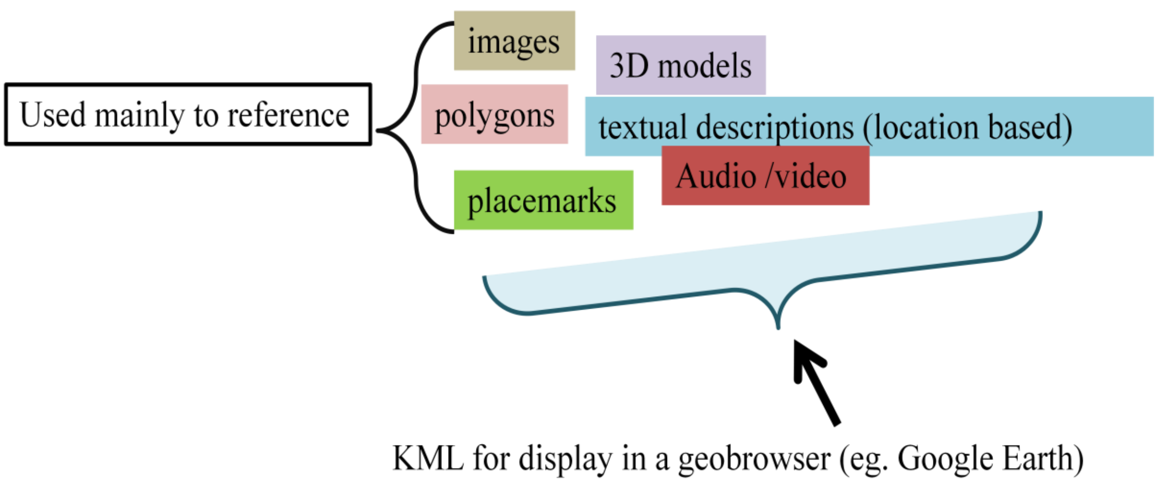


Fig 1. Items that a KML can readily reference

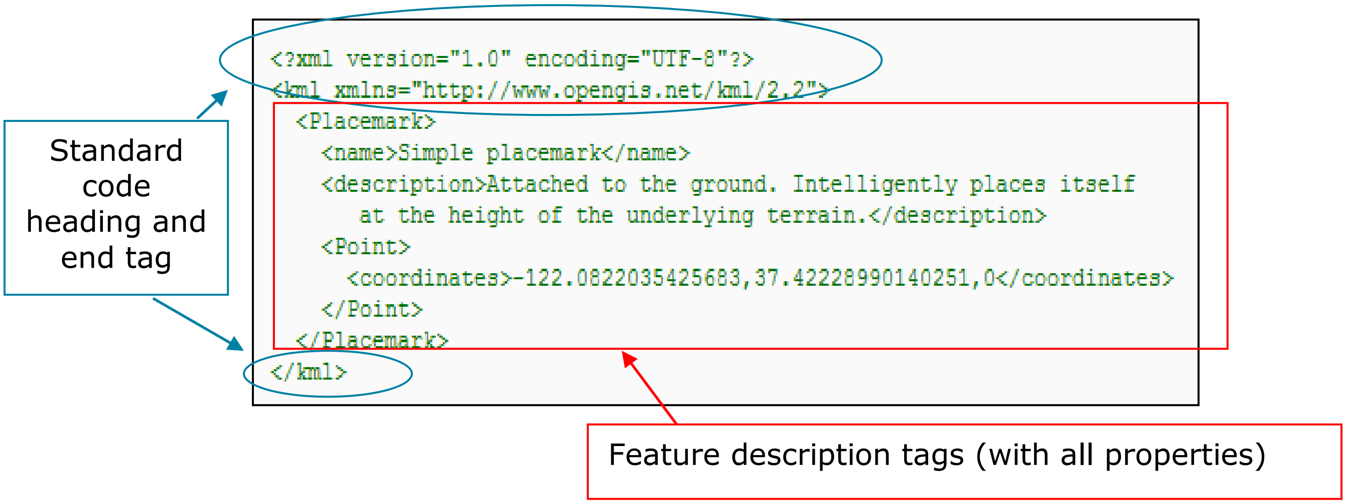


Fig 2. Structure of a KML file

2.2 METHODS

The initial approach is to become familiar with KML structure and used the Google code playground[1]. The code playground is a real time response programming environment that helps programmers test KML codes. The code playground is a powerful tool to give users instant visualization of code manipulation. After getting used to the coding structure, KML files can be implemented in Google earth. **Figure 3** below shows a typical code practice whilst **Figure 4** shows the standard Google Earth KML implementation application. After learning basic coding, geobrowsers were investigated for implementing the proposed visualization techniques. **Table 1** gives descriptions of the most popular tools.

[1] http://code.google.com/apis/ajax/playground/?exp=earth

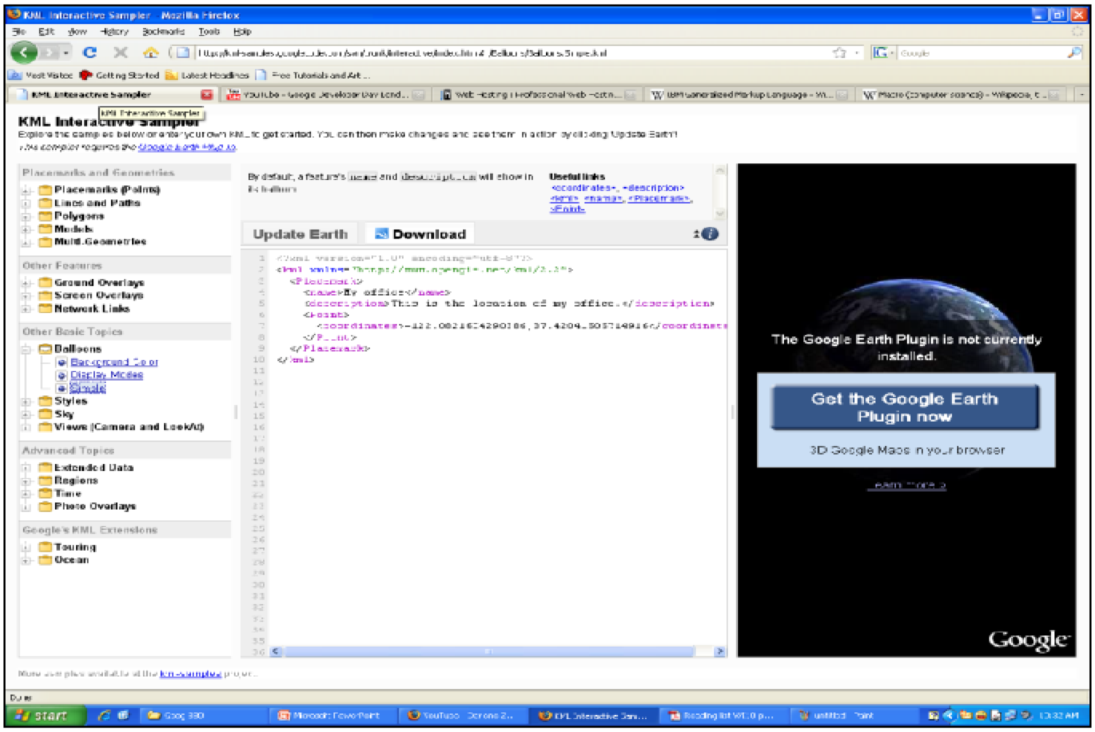


Fig 3. Screenshot of Google earth KML code playground

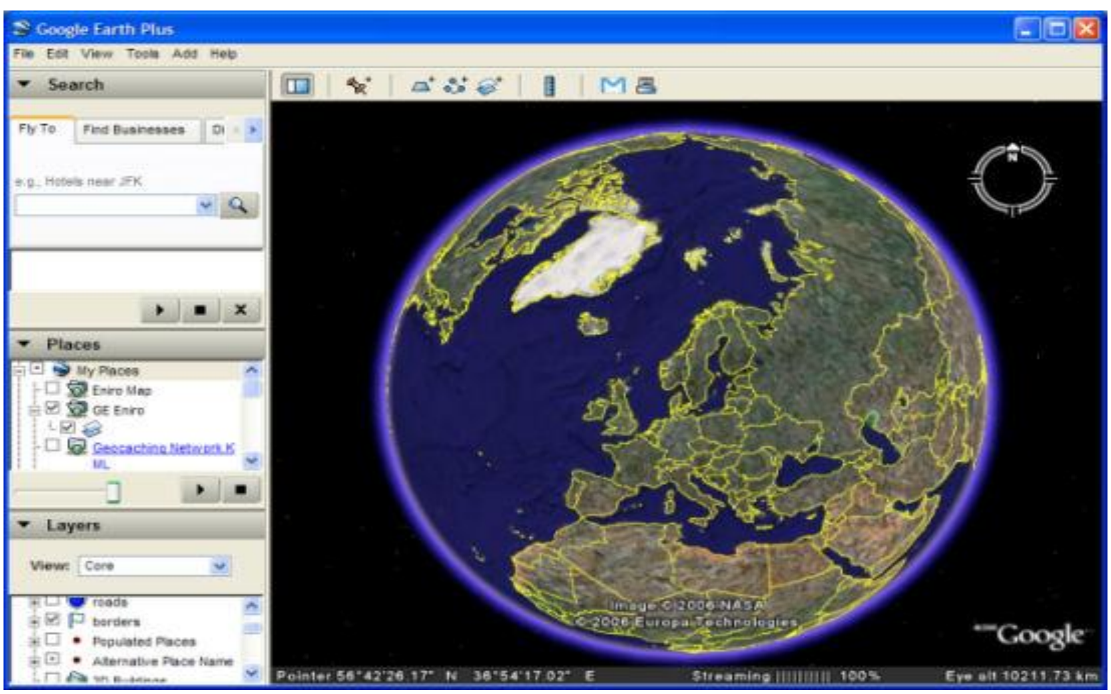
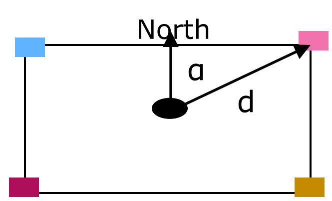


Fig 4. Google earth screenshot

	Geobrowsers	Ownership	2D/3D	KML support	Vector handling performance
1	**Google Earth**	**Proprietary**	**3D**	**Full**	**Good**
2	Google Earth Plug-in	Proprietary	3D	Intermediate	Good
3	Google Maps	Proprietary	2D	Basic	Intermediate
4	Microsoft Live Search	Proprietary	3D	Basic	Intermediate
5	Microsoft Virtual Earth	Proprietary	3D	Basic	Good
6	ArcGIS Explorer	Proprietary	2D/3D	Basic	Good
7	OpenLayers	Open Source	2D	Basic	Intermediate
8	NASA World Wind	Open Source	3D	Basic	Good
9	ossimPlanet	Open Source	3D	Basic	Good

Table 1. Geobrowser performance and feature table

The first implementation was to produce bar maps for the earthquake point data. Using a series of bearing and angle computations aimed at creating vertices of a rectangular object enables the creation of a polygon for each earthquake point. Using KML's extrusion technique the rectangular object was given a tessellated height measure.



ɑ - Bearing from north
d- distance

This methodology proved very useful, so that with labeling techniques in KML, one could now display both the source of data and year of earthquake against each rectangular tower (**Figure 5**). With this initial result in hand one can now create a complex polygon representation using divisions of 360 degrees as the number of polygon sides. The first attempt was to employ a pentagon as shown in **Figure 6** using the code illustrated in **Figure 7.**

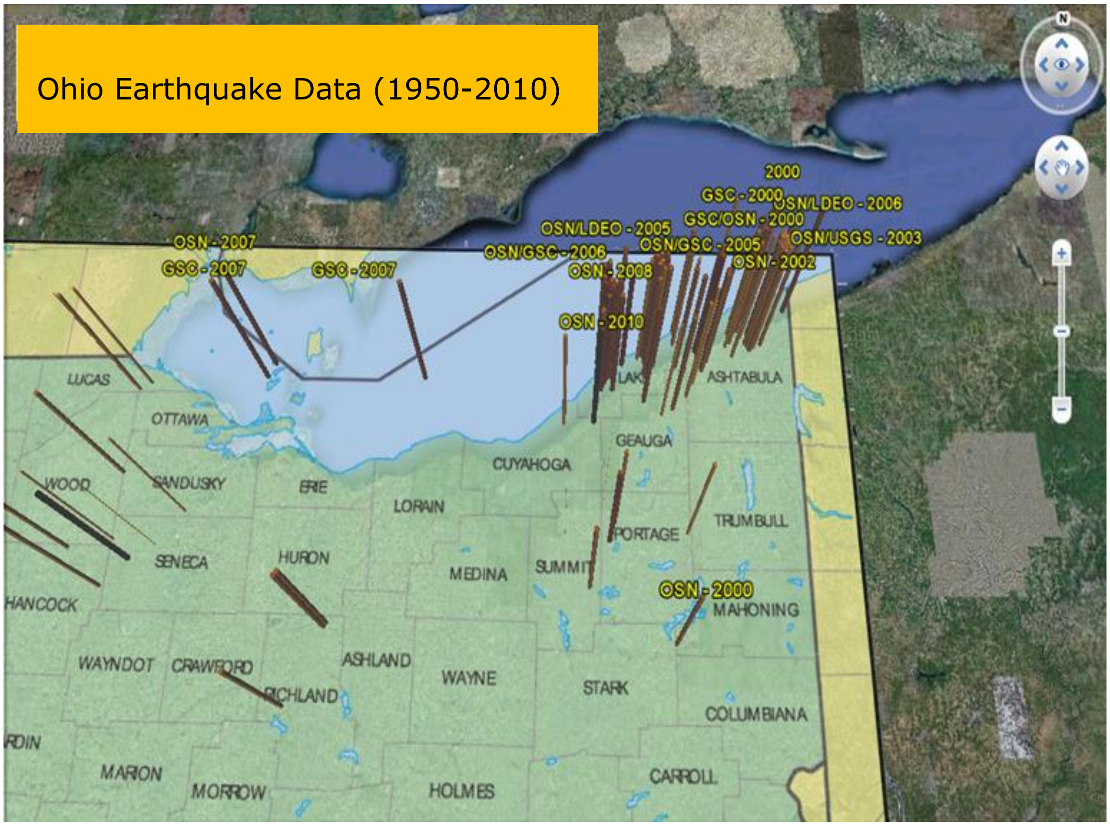


Fig 5. Initial extrusion result for earthquake points

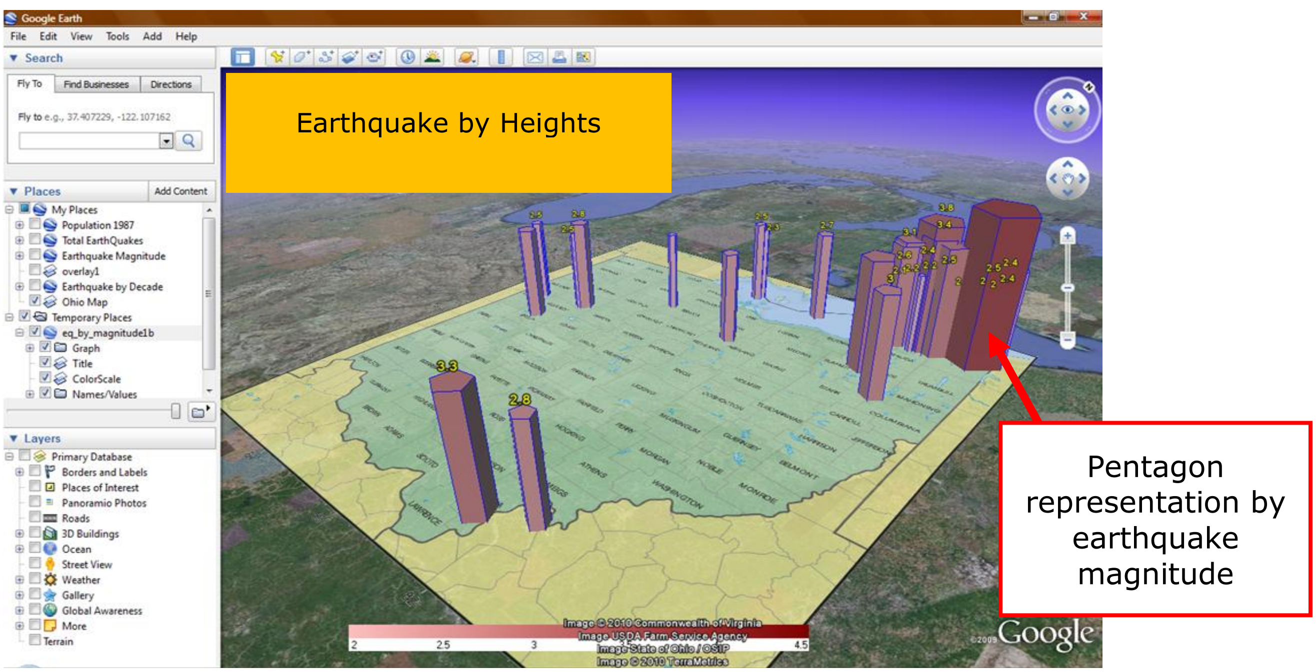


Fig 6. Employing a pentagon shape with size representing earthquake magnitude

```
<Polygon>
  <extrude>1</extrude>
  <altitudeMode>absolute</altitudeMode>
  <outerBoundaryIs>
    <LinearRing>
      <coordinates>
        102.77,36.48,2000000 102.77,30.24,2000000
        110.26,30.24,2000000 110.26,36.48,2000000
        102.77,36.48,2000000
      </coordinates>
    </LinearRing>
  </outerBoundaryIs>
</Polygon>
```

altitude

Fig 7. Implementing heights for polygons (code snippet)

For a GIS attribute table representation, HTML code was inserted into the description tag. A folder structure was also used (**Figure 8**) to separate each thematic layer based on earthquake magnitude to show gradient color for each point group.

Setting up folder structure for themes

Info window cell padding

```
………code before…………….
<Folder>
                    <name>2.5</name>
                    <Placemark id="2">
                              <name>2000</name>
                              <Snippet maxLines="0"></Snippet>
                              <description><![CDATA[<br><br><table
border="1"padding="1"width="97%"><tr><td>YEAR:</td><td>2000</td></tr><tr><td>MONTH:</td><td>10<
/td></tr><tr><td>DAY:</td><td>20</td></tr><tr><td>HOUR:</td><td>23</td></tr><tr><td>MIN:</td><td>26
</td></tr><tr><td>SECOND:</td><td>26.54</td></tr><tr><td>LATITUDE:</td><td>41.91</td></tr><tr><td>L
ONGITUDE:</td><td>-
80.77</td></tr><tr><td>CALCULATE_:</td><td>0</td></tr><tr><td>MAGNITUDE:</td><td>2.5</td></tr><tr>
<td>FELT_AREA:</td><td>0</td></tr><tr><td>COUNTY:</td><td>ASHT</td></tr><tr><td>SOURCE:</td><td>
GSC/OSN</td></tr></table>]]></description>
                              <styleUrl>#trb977</styleUrl>
                              <Point>
                                        <extrude>1</extrude>
                                        <tessellate>1</tessellate>
                                        <altitudeMode>relativeToGround</altitudeMode>
                                        <coordinates>-

…………code after……….
```

Fig 8. Implementing folder structure and information window table form

3.0 RESULTS

Good thematic results were achieved. Distinct themes could be readily identified and the geological features mapped began to show the underlying trends that were not noticed on hard copy maps. For example, a cluster of pentagons in northeastern Ohio was readily apparent. Some of the pentagons were easily identified due to their enormous heights. The inference here is that, earthquakes in the state of Ohio are frequent and have some of the highest magnitudes (**Figure 6**) in Ashtabula County of northeastern Ohio. These could have been very hard to see by an untrained eye. **Figure 9** shows earthquake data thematically arranged to indicate the year of the event, its magnitude, and devastation.

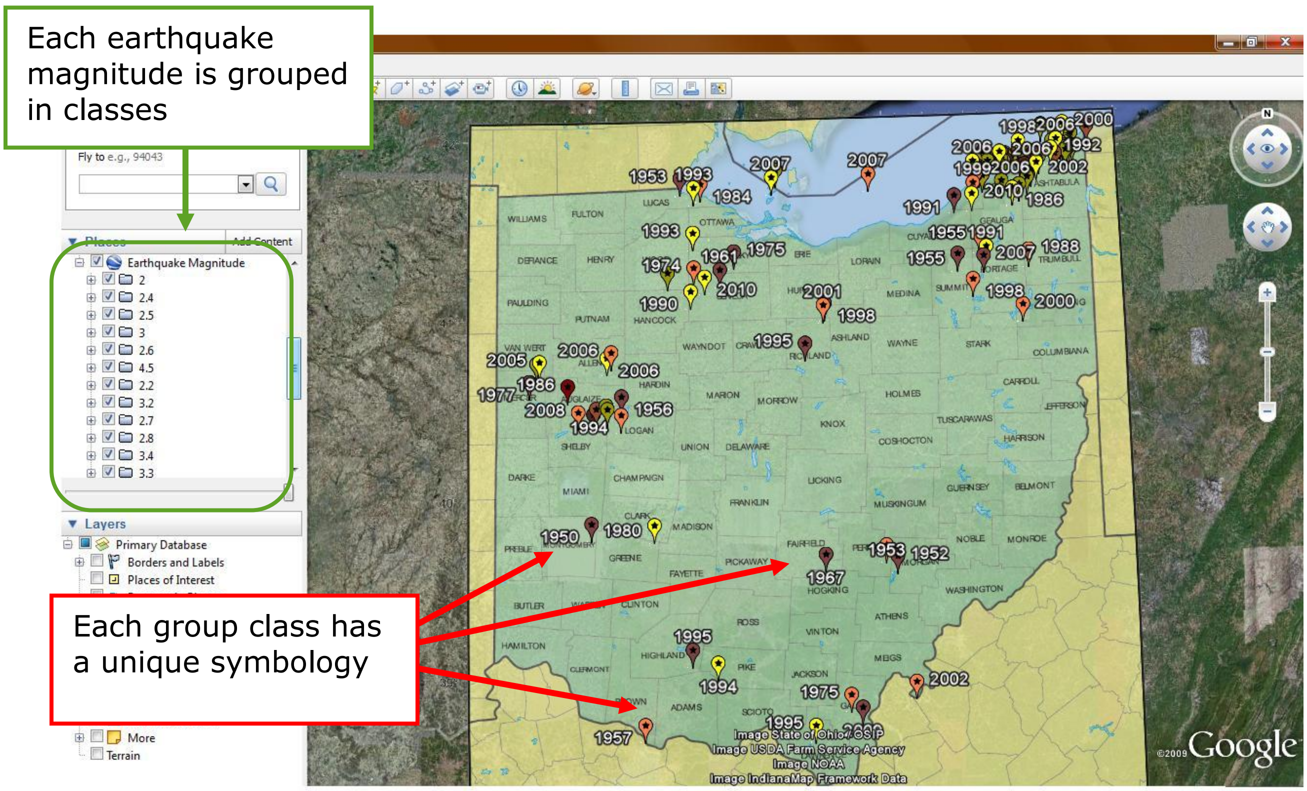


Fig 9. Thematically layered view of earthquake data and tabular information window

Implementing a legend was the next most logical thing to do. This was achieved by creating an image file for the legend in Microsoft paintbrush that was invoked within the KML code. In the KML code, the boundary coordinates of the legend overlay must be specified for it to be placed properly on the Ohio map. **Figure 10**, shows the sample code used to implement the legend.

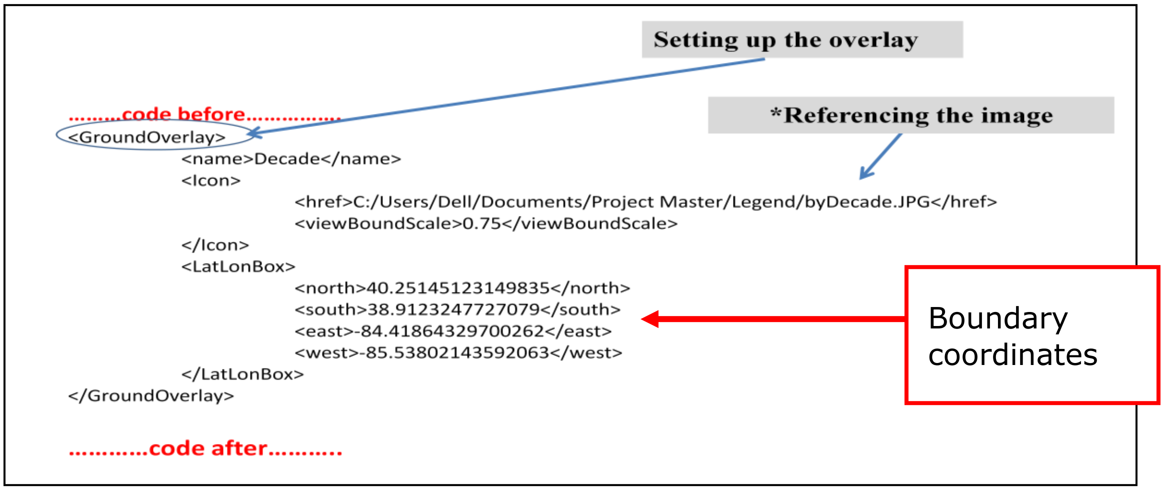


Fig 10. Code snippet for inserting legend and its boundary coordinates

Figure 11 shows a legend implementation. A color ramp was used to differentiate attribute classes (years of occurrences) of earthquakes. This brought more meaning to the map interpretation.

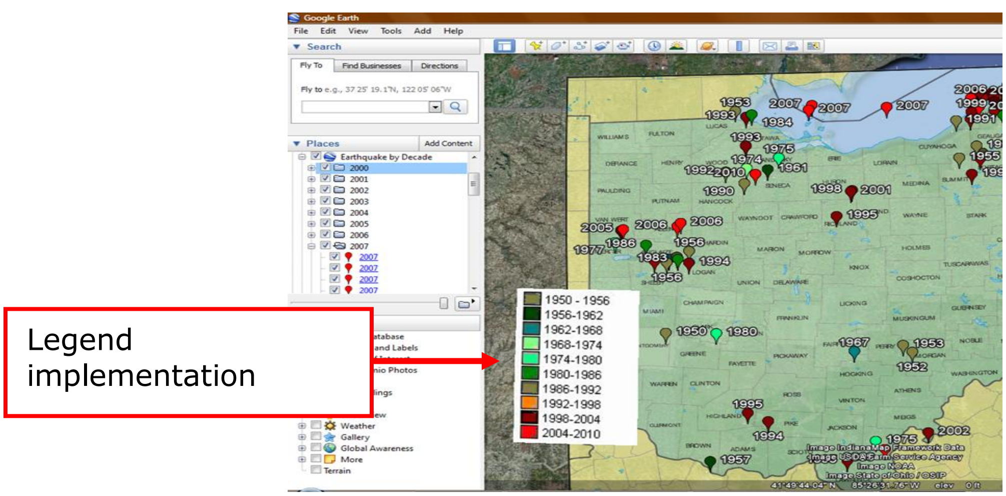


Fig 11. Legend overlay implementation for the earthquakes by Decade theme

An external image can be used as an image overlay. This makes it easy to incorporate images stored on image sharing websites and communities such as Panoramio, Flikr and Picasa. Using ArcGIS to create points along county boundaries one could generate coordinate values for those points and insert them into KML. Using appropriate employment values for each county to create extrusion heights, a visual representation of demographic data could be obtained as shown in **Figure 12**.

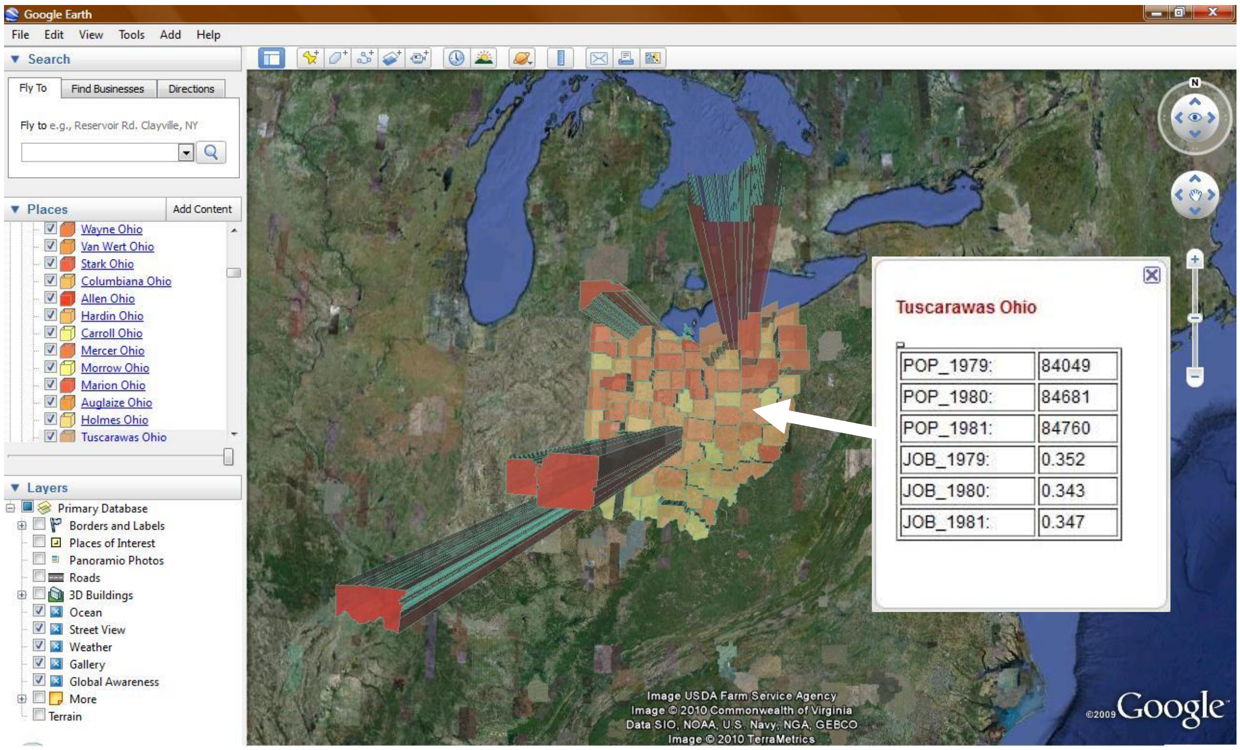


Fig 12. Thematic map showing employment by county for 1987

3.1 ISSUES AND RESOLUTIONS

Scaling was a major issue since there exists no default scaling capability for point objects. We wanted to have point symbols scaled based on their direct proportion (data values). This obstacle was overcome by using a Hypertext Preprocessor (PHP) script since KML does not currently support scaling computations. Thus, the following codes can be used to calculate:

A)1-dimensional symbols (height)

Equation symbolSize = (value / maxValue) * maxSize

PHP $symbolSize = ($value / $maxValue) * $maxSize

For areas of 2-dimensional symbols, the following code can be used:

B) 2-dimensional symbols (area)

Equation symbolSize = power(value / maxValue; 1/2) * maxSize

PHP $symbolSize = ($value / $maxValue) * $maxSize

C) 3-dimensional symbols (volume)

Equation symbolSize = power(value / maxValue; 1/3) * maxSize

PHP symbolSize = pow($value / $maxValue, 1/3) * $maxSize

3-D objects are expressed by cube root of the volume. It is one degree harder for the viewer to assess the relative size of 3-D symbols compared to 2D ones as illustrated in **Figure 13**. An alternative is to use Collada objects (three dimensional designed objects), but these objects cannot be manipulated by point-and-click operations in Windows.

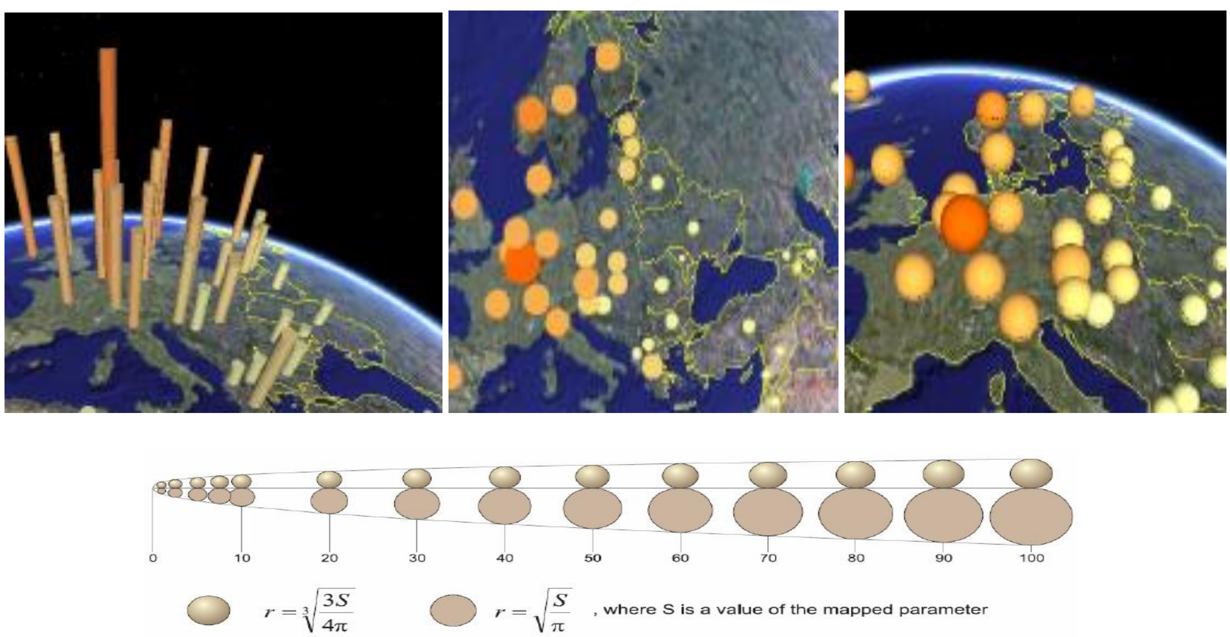
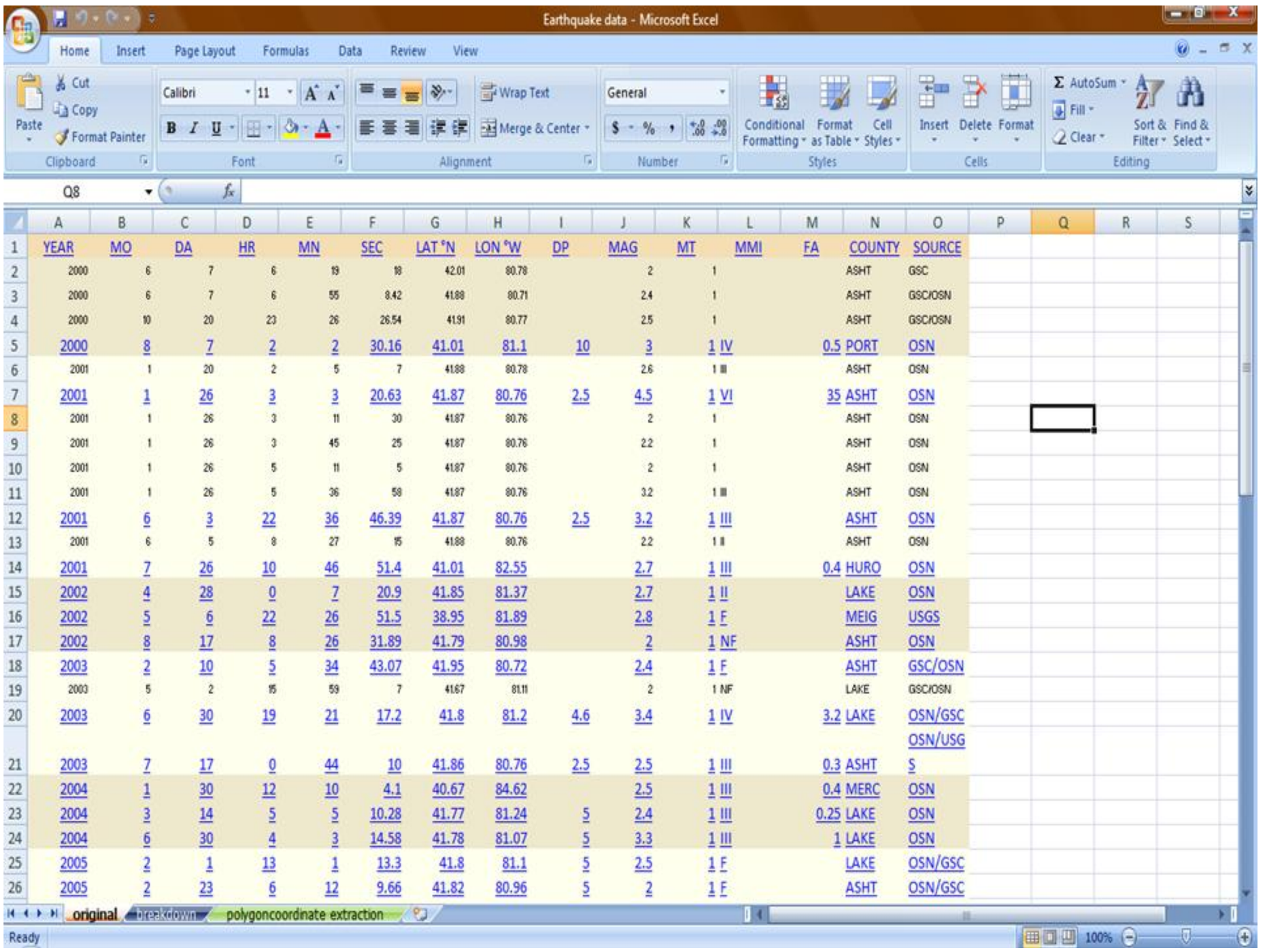


Fig 13. Showing how easy it is to differentiate lower dimension symbols on the globe

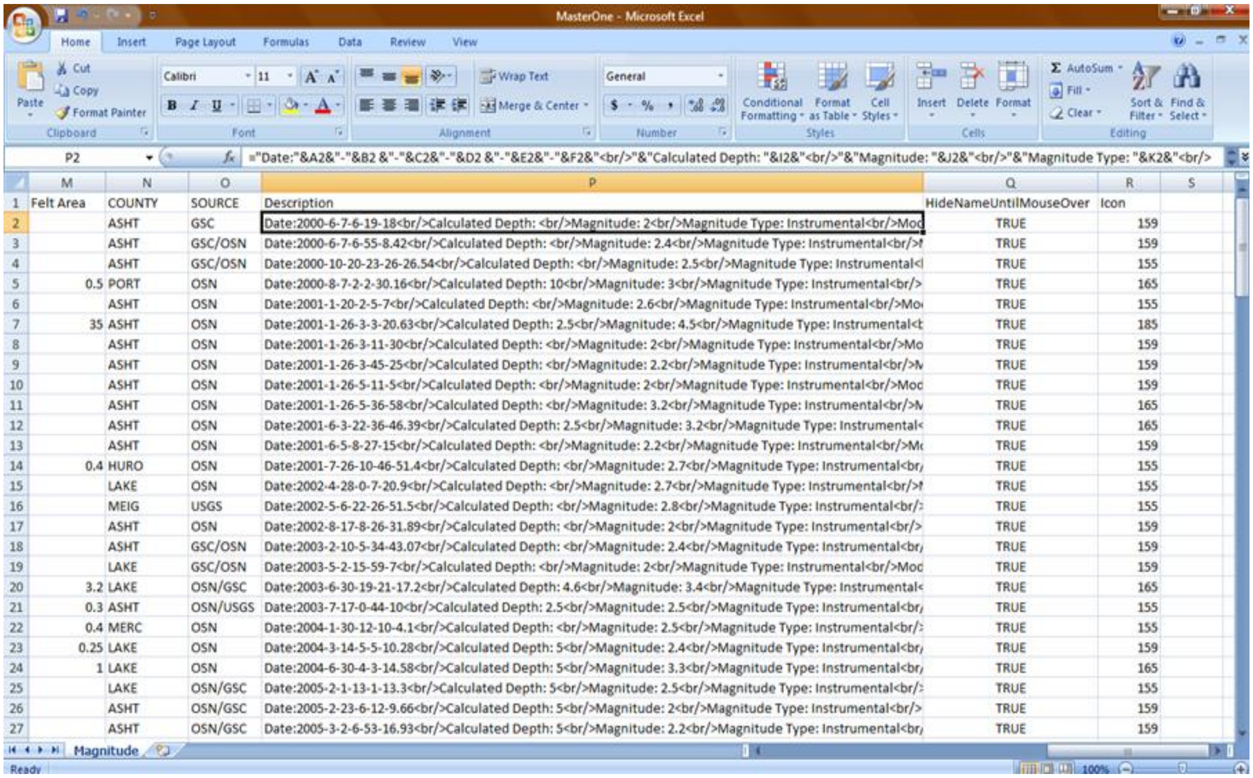
The KML Information Window representation of tabular data was the next issue. The raw data came in tables and there is a need to convert these tables to KML descriptive tags without modifying the original tables. This is necessary because in the original table each row represents an earthquake event. However KML cannot read this Microsoft excel data format readily, so a conversion is needed. **Table 2** shows the format of the raw data in spreadsheet.



YEAR	MO	DA	HR	MN	SEC	LAT °N	LON °W	DP	MAG	MT	MMI	FA	COUNTY	SOURCE
2000	6	7	6	19	18	42.01	80.78		2	1			ASHT	GSC
2000	6	7	6	55	8.42	41.88	80.71		2.4	1			ASHT	GSC/OSN
2000	10	20	23	26	26.54	41.91	80.77		2.5	1			ASHT	GSC/OSN
2000	8	7	2	2	30.16	41.01	81.1	10	3	1	IV	0.5	PORT	OSN
2001	1	20	2	5	7	41.88	80.78		2.6	1	III		ASHT	OSN
2001	1	26	3	3	20.63	41.87	80.76	2.5	4.5	1	VI	35	ASHT	OSN
2001	1	26	3	11	30	41.87	80.76		2	1			ASHT	OSN
2001	1	26	3	45	25	41.87	80.76		2.2	1			ASHT	OSN
2001	1	26	5	11	5	41.87	80.76		2	1			ASHT	OSN
2001	1	26	5	36	58	41.87	80.76		3.2	1	III		ASHT	OSN
2001	6	3	22	36	46.39	41.87	80.76	2.5	3.2	1	III		ASHT	OSN
2001	6	5	8	27	15	41.88	80.76		2.2	1	II		ASHT	OSN
2001	7	26	10	46	51.4	41.01	82.55		2.7	1	III	0.4	HURO	OSN
2002	4	28	0	7	20.9	41.85	81.37		2.7	1	II		LAKE	OSN
2002	5	6	22	26	51.5	38.95	81.89		2.8	1	F		MEIG	USGS
2002	8	17	8	26	31.89	41.79	80.98		2	1	NF		ASHT	OSN
2003	2	10	5	34	43.07	41.95	80.72		2.4	1	F		ASHT	GSC/OSN
2003	5	2	15	59	7	41.67	81.11		2	1	NF		LAKE	GSC/OSN
2003	6	30	19	21	17.2	41.8	81.2	4.6	3.4	1	IV	3.2	LAKE	OSN/GSC
2003	7	17	0	44	10	41.86	80.76	2.5	2.5	1	III	0.3	ASHT	OSN/USGS
2004	1	30	12	10	4.1	40.67	84.62		2.5	1	III	0.4	MERC	OSN
2004	3	14	5	5	10.28	41.77	81.24	5	2.4	1	III	0.25	LAKE	OSN
2004	6	30	4	3	14.58	41.78	81.07	5	3.3	1	III	1	LAKE	OSN
2005	2	1	13	1	13.3	41.8	81.1	5	2.5	1	F		LAKE	OSN/GSC
2005	2	23	6	12	9.66	41.82	80.96	5	2	1	F		ASHT	OSN/GSC

Table 2. Screenshot of raw spreadsheet form of earthquake data

To accomplish this task concatenation techniques in Microsoft excel can be used and the result complemented with HTML tags with the spreadsheet formula. The result was converted to XML and then into KML as shown in **Figure 14**.



	M	N	O	P	Q	R
1	Felt Area	COUNTY	SOURCE	Description	HideNameUntilMouseOver	Icon
2		ASHT	GSC	Date:2000-6-7-6-19-18 Calculated Depth: Magnitude: 2 Magnitude Type: Instrumental Mod	TRUE	159
3		ASHT	GSC/OSN	Date:2000-6-7-6-55-8.42 Calculated Depth: Magnitude: 2.4 Magnitude Type: Instrumental 	TRUE	159
4		ASHT	GSC/OSN	Date:2000-10-20-23-26-26.54 Calculated Depth: Magnitude: 2.5 Magnitude Type: Instrumental<	TRUE	155
5	0.5	PORT	OSN	Date:2000-8-7-2-2-30.16 Calculated Depth: 10 Magnitude: 3 Magnitude Type: Instrumental 	TRUE	165
6		ASHT	OSN	Date:2001-1-20-2-5-7 Calculated Depth: Magnitude: 2.6 Magnitude Type: Instrumental Mo	TRUE	155
7	35	ASHT	OSN	Date:2001-1-26-3-3-20.63 Calculated Depth: 2.5 Magnitude: 4.5 Magnitude Type: Instrumental<	TRUE	185
8		ASHT	OSN	Date:2001-1-26-3-11-30 Calculated Depth: Magnitude: 2 Magnitude Type: Instrumental Mo	TRUE	159
9		ASHT	OSN	Date:2001-1-26-3-45-25 Calculated Depth: Magnitude: 2.2 Magnitude Type: Instrumental M	TRUE	159
10		ASHT	OSN	Date:2001-1-26-5-11-5 Calculated Depth: Magnitude: 2 Magnitude Type: Instrumental Mod	TRUE	159
11		ASHT	OSN	Date:2001-1-26-5-36-58 Calculated Depth: Magnitude: 3.2 Magnitude Type: Instrumental M	TRUE	165
12		ASHT	OSN	Date:2001-6-3-22-36-46.39 Calculated Depth: 2.5 Magnitude: 3.2 Magnitude Type: Instrumental<	TRUE	165
13		ASHT	OSN	Date:2001-6-5-8-27-15 Calculated Depth: Magnitude: 2.2 Magnitude Type: Instrumental M	TRUE	159
14	0.4	HURO	OSN	Date:2001-7-26-10-46-51.4 Calculated Depth: Magnitude: 2.7 Magnitude Type: Instrumental<br/	TRUE	155
15		LAKE	OSN	Date:2002-4-28-0-7-20.9 Calculated Depth: Magnitude: 2.7 Magnitude Type: Instrumental 	TRUE	155
16		MEIG	USGS	Date:2002-5-6-22-26-51.5 Calculated Depth: Magnitude: 2.8 Magnitude Type: Instrumental 	TRUE	155
17		ASHT	OSN	Date:2002-8-17-8-26-31.89 Calculated Depth: Magnitude: 2 Magnitude Type: Instrumental 	TRUE	159
18		ASHT	GSC/OSN	Date:2003-2-10-5-34-43.07 Calculated Depth: Magnitude: 2.4 Magnitude Type: Instrumental<br/	TRUE	159
19		LAKE	GSC/OSN	Date:2003-5-2-15-59-7 Calculated Depth: Magnitude: 2 Magnitude Type: Instrumental Mod	TRUE	159
20	3.2	LAKE	OSN/GSC	Date:2003-6-30-19-21-17.2 Calculated Depth: 4.6 Magnitude: 3.4 Magnitude Type: Instrumental<	TRUE	165
21	0.3	ASHT	OSN/USGS	Date:2003-7-17-0-44-10 Calculated Depth: 2.5 Magnitude: 2.5 Magnitude Type: Instrumental<br/	TRUE	155
22	0.4	MERC	OSN	Date:2004-1-30-12-10-4.1 Calculated Depth: Magnitude: 2.5 Magnitude Type: Instrumental 	TRUE	155
23	0.25	LAKE	OSN	Date:2004-3-14-5-5-10.28 Calculated Depth: 5 Magnitude: 2.4 Magnitude Type: Instrumental<br/	TRUE	159
24	1	LAKE	OSN	Date:2004-6-30-4-3-14.58 Calculated Depth: 5 Magnitude: 3.3 Magnitude Type: Instrumental<br/	TRUE	165
25		LAKE	OSN/GSC	Date:2005-2-1-13-1-13.3 Calculated Depth: 5 Magnitude: 2.5 Magnitude Type: Instrumental 	TRUE	155
26		ASHT	OSN/GSC	Date:2005-2-23-6-12-9.66 Calculated Depth: 5 Magnitude: 2 Magnitude Type: Instrumental 	TRUE	159
27		ASHT	OSN/GSC	Date:2005-3-2-6-53-16.93 Calculated Depth: 5 Magnitude: 2.2 Magnitude Type: Instrumental<br/	TRUE	159

Fig. 14. Creation of tabular HTML tags for KML implementation of the spreadsheet in **Table 2**

4.0 CONCLUSION

The techniques described in this thesis involved passive knowledge in other programming languages such as PHP and HTML. There was also a need to be comfortable with Visual Basic for Applications (VBA) in Microsoft excel. It is clearly achievable to implement standard GIS and advance visualizations with Google's KML for thematic mapping.

A major drawback in KML implementation is the redundancies in data representation; since tags have to be repeated frequently for objects with minor attribute differences. It is my hope that in the future, Geobrowser vendors will help improve native support for thematic mapping and 3D visual representations via KML implementation. Presently the only alternative that is robust to KML is using GIS servers such as ArcGIS or Mapserver. The drawback with these systems is that they don't readily allow data manipulation, collaborative editing or the interoperability that KML offers with diverse data origins and formats.

4.1 PROPOSED FUTURE WORK

There is a lot that can be done using KML for Advanced 3D visualization. Below is a list of recommendations to extend the results of this thesis:

- Enhance visualization of terrain data and other geological interest datasets.
- Create animated time stamps for temporal data.
- Improve box symbols that I implemented as trapezoids due to the map projection.
- Create a web interface which can automatically accept spreadsheet uploads and plot user preferred visualizations.

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OhioSeis earthquake data (1950-2010)➔ www.dnr.state.oh.us/ohioseis

UN world economic data➔ http://unstats.un.org/unsd/default.htm

US census, population and employment data➔ http://www.census.gov/cps/

6.0 APPENDICES

6.1 APENDIX A: DATASETS USED FOR STUDY

a) – OhioSeis earthquake data

b) - UN world economic data

c) - US Census population and employment data

6.2 APPENDIX B: VIEW OF RAW EARTHQUAKE DATA

ID	YEAR	MO	DA	HR	MN	SEC	LAT_N	LON_W	DEPTH	MAGNITUDE	MAG. TYPE	MODIFIED MERCIALLI INTENSITY	FELT AREA	COUNTY	SOURCE
1	2000	6	7	6	19	18.00	42.01	-80.78		2.0	1			ASHT	GSC
2	2000	6	7	6	55	8.42	41.88	-80.71		2.4	1			ASHT	GSC/OSN
3	2000	10	20	23	26	26.54	41.91	-80.77		2.5	1			ASHT	GSC/OSN
4	2000	8	7	2	2	30.16	41.01	-81.10	10.0	3.0	1	IV	0.50	PORT	OSN
5	2001	1	20	2	5	7.00	41.88	-80.78		2.6	1	III		ASHT	OSN
6	2001	1	26	3	3	20.63	41.87	-80.76	2.5	4.5	1	VI	35.00	ASHT	OSN
7	2001	1	26	3	11	30.00	41.87	-80.76		2.0	1			ASHT	OSN
8	2001	1	26	3	45	25.00	41.87	-80.76		2.2	1			ASHT	OSN
9	2001	1	26	5	11	5.00	41.87	-80.76		2.0	1			ASHT	OSN
10	2001	1	26	5	36	58.00	41.87	-80.76		3.2	1	III		ASHT	OSN
11	2001	6	3	22	36	46.39	41.87	-80.76	2.5	3.2	1	III		ASHT	OSN
12	2001	6	5	8	27	15.00	41.88	-80.76		2.2	1	II		ASHT	OSN
13	2001	7	26	10	46	51.40	41.01	-82.55		2.7	1	III	0.40	HURO	OSN
14	2002	4	28	0	7	20.90	41.85	-81.37		2.7	1	II		LAKE	OSN
15	2002	5	6	22	26	51.50	38.95	-81.89		2.8	1	F		MEIG	USGS
16	2002	8	17	8	26	31.89	41.79	-80.98		2.0	1	NF		ASHT	OSN
17	2003	2	10	5	34	43.07	41.95	-80.72		2.4	1	F		ASHT	GSC/OSN
18	2003	5	2	15	59	7.00	41.67	-81.11		2.0	1	NF		LAKE	GSC/OSN
19	2003	6	30	19	21	17.20	41.80	-81.20	4.6	3.4	1	IV	3.20	LAKE	OSN/GSC
20	2003	7	17	0	44	10.00	41.86	-80.76	2.5	2.5	1	III	0.30	ASHT	OSN/USGS
21	2004	1	30	12	10	4.10	40.67	-84.62		2.5	1	III	0.40	MERC	OSN
22	2004	3	14	5	5	10.28	41.77	-81.24	5.0	2.4	1	III	0.25	LAKE	OSN
23	2004	6	30	4	3	14.58	41.78	-81.07	5.0	3.3	1	III	1.00	LAKE	OSN
24	2005	2	1	13	1	13.30	41.80	-81.10	5.0	2.5	1	F		LAKE	OSN/GSC

25	2005	2	23	6	12	9.66	41.82	-80.96	5.0	2.0	1	F		ASHT	OSN/GSC
26	2005	3	2	6	53	16.93	41.80	-80.98	5.0	2.2	1	NF		ASHT	OSN/GSC
27	2005	3	13	4	2	4.49	40.68	-84.60	5.0	2.2	1	F		MERC	OSN/GSC
28	2005	11	13	11	2	15.77	41.84	-81.21	6.4	2.2	1	F		LAKE	OSN/LDEO
29	2005	12	11	5	20	2.38	41.95	-80.84	9.9	2.0	1	F		ASHT	OSN/LDEO
30	2006	1	6	3	2	2.69	41.77	-81.45	5.0	2.6	1	F		LAKE	OSN/GSC
31	2006	1	13	15	32	17.55	41.80	-81.45	7.0	2.3	1	F		LAKE	OSN/LDEO
32	2006	2	10	13	30	42.00	41.75	-81.41	5.0	2.6	1	F		LAKE	OSN/GSC
33	2006	2	27	20	53	20.48	41.92	-80.83	5.0	2.0	1	NF		ASHT	OSN/GSC
34	2006	3	11	12	27	15.16	41.76	-81.39	5.0	3.0	1	F		LAKE	OSN/GSC
35	2006	3	27	17	24	30.35	41.75	-81.41	5.0	2.1	1	NF		LAKE	OSN/GSC
36	2006	4	10	5	55	52.49	41.92	-80.82	10.0	2.0	1	NF		LAKE	OSN/LDEO
37	2006	5	12	1	51	11.07	40.74	-84.08	5.0	2.8	1	III		ALLE	OSN
38	2006	5	21	14	15	28.63	41.81	-81.43	5.0	2.2	1	NF		LAKE	OSN/GSC
39	2006	6	20	20	11	18.54	41.84	-81.23	4.0	3.8	1	F		LAKE	OSN
40	2006	6	20	20	57	22.94	41.81	-81.24	5.0	2.2	1	NF		LAKE	OSN
41	2006	6	22	10	9	45.48	41.85	-81.25	5.0	2.3	1	NF		LAKE	GSC
42	2006	6	28	13	18	28.38	41.69	-81.24	5.0	2.3	1	F		LAKE	GSC
43	2006	7	1	5	25	53.19	41.83	-81.25	5.0	2.1	1	NF		LAKE	GSC
44	2006	8	15	6	8	54.94	40.71	-84.11	5.0	2.5	1	F		ALLE	OSN
45	2007	1	22	6	17	10.20	41.83	-81.21	6.0	2.2	1	NF		LAKE	OSN
46	2007	3	12	23	18	16.41	41.28	-81.38	5.0	3.3	1	IV		PORT	OSN
47	2007	4	12	22	3	20.74	41.71	-82.93	5.0	2.5	1	NF		OTTA	GSC
48	2007	4	24	1	9	50.18	41.75	-82.90	5.0	2.3	1	NF		OTTA	OSN
49	2007	8	27	23	26	44.07	41.72	-81.38	5.0	2.1	1	F		LAKE	OSN
50	2007	9	28	8	46	5.81	41.99	-80.60	5.0	2.7	1	F		ASHT	OSN
51	2007	10	16	17	5	1.55	41.76	-81.42	5.0	2.4	1	NF		LAKE	OSN
52	2007	10	17	20	4	9.74	41.75	-81.42	5.0	3.2	1	III		LAKE	OSN
53	2007	10	18	22	23	4.23	41.73	-82.22	5.0	2.7	1	NF		LORA	GSC

54	2008	1	9	1	34	46.70	41.72	-81.43	5.0	3.1	1	F		LAKE	OSN
55	2008	8	14	18	32	16.44	41.85	-81.01	5.0	2.3	1	NF		LAKE	OSN
56	2008	9	18	1	4	16.57	41.78	-81.43	5.0	2.8	1	F		LAKE	OSN
57	2008	9	20	19	16	43.19	41.74	-81.42	5.0	2.3	1	NF		LAKE	OSN
58	2008	9	30	1	6	38.58	40.41	-84.31	5.0	2.8	1	IV	6.75	SHEL	OSN
59	2009	2	14	13	16	27.16	41.84	-81.00	5.0	2.6	1	F		ASHT	OSN
60	2009	2	23	23	32	27.26	41.75	-81.44	5.0	2.2	1	NF		LAKE	GSC
61	2009	4	24	13	42	46.03	38.81	-82.27	5.0	3.3	1	IV	F	GALL	OSN
62	2009	10	21	17	59	46.85	41.80	-81.34	5.0	2.4	1	NF		LAKE	OSN, GSC
63	2010	2	4	17	44	21.30	41.62	-81.46	5.0	2.1	1	II	F	LAKE	OSN
64	2010	2	25	22	13	13.27	41.16	-83.41	5.0	2.4	1	III	F	SENE	OSN

6.3 GOOGLE'S KML HIERARCHY STRUCTURE DIAGRAM

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